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RADIUM

A MONTHLY JOURNAL DEVOTED TO THE CHEMISTRY, PHYSICS AND THERAPEUTICS OF RADIUM AND OTHER RADIO-ACTIVE SUBSTANCES

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VOL. I JUNE, 1913 NO. 3

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PUBLISHED BY
THE RADIUM PUBLISHING COMPANY
PITTSBURGH, PA.

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RADIUM

A Monthly Journal Devoted to the Chemistry, Physics and Therapeutics of Radium and Other Radio-Active Substances

Published by THE RADIUM PUBLISHING COMPANY
Forbes and Meyran Avenues, Pittsburgh, Pa.

We shall be glad to receive for publication from our subscribers and readers articles pertaining to the subject of radium and its application. All inquiries for information will be accorded prompt attention, and will be answered either by letter or through the columns of this paper.

Vol. I JUNE, 1913 No. 3

Recent Work on the Transmutation of Elements

PART I

By A. T. Cameron

Assistant Professor of Physiological Chemistry, University of Manitoba.

In his recent work on "Radio-active Substances and Their Radiations" Professor *Rutherford* (1) thus outlines the guiding idea of those who are engaged in one of the most fascinating and baffling problems, equally in modern and in ancient times: "Since there are strong reasons for supposing that the radiations from active matter actually penetrate the atoms in their path, it seems not impossible that the radiations might themselves cause a disintegration of some of the atoms of matter which they traverse. In consequence of the great energy associated with the alpha particles expelled from active matter, it is to be expected that the alpha rays would be most effective." His conclusions from the published data are: "There is, so far, no good evidence that the ordinary inactive chemical elements can be transformed by the radiations from active matter. On the other hand there is indubitable evidence that atomic transformations spontaneously occur in the radio-active elements themselves."

Before considering recent work on transformation it is desirable to review briefly the results on which *Rutherford* based his conclusions. In the years 1907-09 a series of papers were published by Sir William *Ramsay* and his co-workers (2); in these certain facts were stated, and from these facts certain conclusions were tentatively drawn. An attempt to decompose solutions of copper salts with radium emanation (niton) resulted in no liberation of metallic copper. Analysis after treatment revealed though the spectrum a trace of lithium. There were several possible sources. It might have come from the glass and silica vessels employed during the treatment of the salt with emanation, and the

subsequent analysis. It might be present as an impurity in the copper salt or the reagents employed. It might be formed as a product of the action of the emanation. These possibilities were tested in a series of special experiments.

The pure copper salt, confined for the same length of time in a sealed vessel of the same glass, then subjected to analysis in the same silica vessels, with the same reagents, gave no trace of lithium. This apparently showed that the lithium came neither from the salt, nor from the glass and silica, nor from the reagents. It might be dissolved from the glass through the alpha ray bombardment. A parallel experiment to test this point was made in which distilled water was substituted for the copper solution. No lithium was found. The final supposition seemed therefore not unlikely. Lithium itself is that member of the copper group of least atomic weight, and *Ramsay* suggested that here there might be an unusual degradation, of copper into lithium, induced through the action of the radio-active bombardment. At the same time it was observed that in the experiment with distilled water the gases when examined showed the presence of neon. It was not thought that such an amount of neon could be obtained from air leakage, and it was suggested that it had been also produced by an atomic change. This formation of neon was confirmed in subsequent experiments.

Experiments were carried out with over 200 c.c of a *thorium* solution, in which the gases evolved were examined every second or third month. They consisted chiefly of nitrogen and carbon dioxide. While the former decreased, suggesting adsorption on the walls of the containing vessel as its source, the latter remained proportional in amount to the time of accumulation. Carbon is the member of the thorium group of lowest atomic weight. It appeared possible that here a similar change took place to that in the copper experiments. Further experiments were made in which the relatively feeble alpha ray bombardment from thorium and its products was supplemented by that from radium emanation, and other elements of the thorium group were also treated with the emanation. The amounts of solution were only 2 or 3 c.c. While a check experiment with a lead salt gave only the merest trace of carbon dioxide, in experiments with thorium, zirconium, titanium, and silicon salts quantities of this gas ranging from 0.06 c.c. (silicon) to 0.55 c.c. (thorium) were obtained where the total space was only 2 or 3 c.c., and there was practically no possibility of air leakage. These results also appeared to support the theory of a degradation of carbon. So much for the positive side of the question.

Mme. *Curie* and Mlle. *Gleditsch* (3) attacked the copper-lithium problem. They found that when pure water remained for some time in a glass or silica vessel, and was then evaporated, the small residue contained a trace of lithium. They therefore carried out the whole of their experiments—otherwise similar to those of *Ramsay*—in platinum vessels, and obtained no lithium. *Rutherford* and *Royds* (4) tested the formation of neon in experiments with distilled water. They found that when one-fifteenth of a c.c. of air was subjected to the same analytical treatment (separation by charcoal cooled to liquid air temperature, and spectral analysis), neon was perceptible in the spectrum of the residual gas. They devised special apparatus to exclude air leakage completely. They obtained no neon. *Herschfinkel* (5) carried out experiments *not* exactly parallel to *Ramsay's* since he subjected large amounts of thorium salt solutions to the action of radium emanation. He obtained carbon

dioxide. He obtained *more* carbon dioxide when he replaced the emanation by small quantities of potassium permanganate. He concluded that the carbon dioxide resulted from traces of organic matter, destroyed alike by emanation and permanganate, that these were probably traces of oxalate present in the thorium nitrate used, and that this was the cause of the carbon dioxide in *Ramsay's* experiments. *Ramsay* (6) answered that in his later experiments all organic matter was removed by initially heating the thorium nitrate to redness, and that *Herschfinkel's* explanation applied, therefore, only to his own results, and not to the original ones of *Ramsay*.

At this stage the problems remained for some time. It will be observed that there is in each case one series of experiments for, and one against, each suggested transmutation. I shall now deal briefly with the more recent work.

In a paper published a year ago *Ramsay* (7) states, referring to his previous work, "It appears to have been generally assumed that the neon found by us owed its presence to atmospheric contamination. I have now other evidence which make it almost certain that neon is either a product of degradation of niton, or is produced by the action of niton on water, preferably the latter alternative." His evidence is both observational and experimental. The experimental evidence adduced consists in a measurement of the amounts of residual gases (neon and helium) obtained after treatment of thorium nitrate solution with radium emanation in a small bulb under conditions which excluded air leakage. He obtained 0.485 cubic millimetre of inert gas. Of this 0.308 was helium, according to calculation from the known radio-active transformations. The neon spectrum was possibly strong enough to account for the remainder, 0.177 cubic millimetre. *Ramsay* and *Collie* estimated from the relative brightness of the spectra in the mixed gas that the neon was at any rate present in amount one-quarter that of helium, while 0.05 cubic millimetre would imply a leakage of 4 c.c. air, were air the source. Absence of argon confirmed absence of air.

The *observational* evidence brought forward was derived from analyses of the gases liberated from the mineral springs at *Bath, England*. The King's Well there liberates in 24 hours 5 cubic metres of gas, containing per litre 36 c.c. of carbon dioxide and 964 c.c. of nitrogen and inert gases (7.263 c.c. argon, 2.334 c.c. neon, 0.297 c.c. helium). Both water and gas contained radium emanation. The water contained a trace of radium. Atomspheric air per litre contains 9.32 c.c. argon, 0.0124 c.c. neon, and 0.00408 c.c. helium, so that while the evolved gases contained only 0.78 times the atmospheric content of argon, they contained 188 times the corresponding amount of neon, 73 times that of helium. The helium (1.5 litres per 24 hours) could be attributed to the normal radio-active transformations. The relatively enormous liberation of neon (12.5 litres per 24 hours), and the presence of neon in the experiment described, *Ramsay* considered best explained as due to the action of radium emanation on water.

In all the work so far described, atomic change, if change took place, could be ascribed chiefly to the action of alpha rays, electrically charged helium atoms moving at high speed. In the subsequent experiments the changes postulated are ascribed to the action of cathode rays — to the electrons, with far minuter mass, but moving with greater speed.

(To be continued in the next number, which will include the table of references.)

NOTES AND COMMENTS

In the May 17 number of the Journal of the American Medical Association we note the following abstract of a paper on "Radium in Surgery," delivered at the annual meeting of the New York Medical Society at Rochester, N. Y., April 28-30, by Dr. Howard A. *Kelly,* of Baltimore, Md.:

"Radium is destined to produce a change in surgical and medical work not less marked than the introduction of the Roentgen ray, perhaps even more decided. Radium in surgery will definitely cure many forms of cancer, especially in the early stages; it will cure 96 per cent. of skin cancer, recurrent uterine cancers if taken early, and some cases of rectal cancers; it acts most favorably upon parotid growths; it will cure some cancers of the lip, tongue and breast, and acts also very positively on sarcomas. It also cures various other fibrous and epithelial growths, especially on the surface of the body. One of its happiest effects is in curing angiomas, even the large vascular growth which cannot be treated at all surgically. In gynecology radium acts happily, outside of its value in cancer, in checking the growth of fibroid tumors, in stopping uterine hemorrhages and in relieving some forms of pelvic inflammatory trouble. One of its happiest uses is in the cure of obstinate pruritus of the vulva and anus. In exophthalmic goiter there is promise for a definite field of utility. Its use in surgery, dermatology and medicine bids fair to bring about either a realignment or a readjustment of the work in these special branches."

* * * * *

The fourth International Congress for Physio Therapy was held in Berlin from the 26th to the 30th of March. The following papers, referring to radium therapy, were read:

Dr. *Wickham* (Paris): "The Morphological Effects of Radium Rays."

Dr. W. *Falta* (Vienna): "Chemical and Biological Effects of Radio-active Elements."

Dr. *Degrais* (Paris): "Treatment of Rhinophyama with Radium."

Dr. *Giraud* (Paris): "Absorption of Radium Rays in Tissues."

Dr. *Mesernitzky* (St. Petersburg): "Radium Emanation Therapy in Gout."

Dr. *Marckwald* (Berlin): "The Disintegration Theory of Radio-active Elements."

Dr. *Salle* (Berlin): "Biological Effects of Thorium X."

Dr. *Stefan Meyer* (Vienna): "Radium Standard and Methods for Measuring Radium."

Dr. *Sieveking* (Karlsruhe): "The Measurement of Radio-activity of Springs."

Dr. *Delherme* (Paris): "Treatment of Sciatica with Radium."

Dr. *Werner* (Heidelberg): "Radio Therapy and Radium Therapy of Neoplasms."

Dr. *Beclere* (Paris): "Radium Treatment of Acromelalgia, Gigantism and Pituitary Tumors."

Dr. *von Scuffert* (Munich): "Mesothorium and X-ray in Treatment of Carcinoma of the Uterus."

* * * * *

Dr. Otto *Brill*, director of the Radium Research Laboratory of the Standard Chemical Company of Pittsburgh, has gone abroad for a two months' vacation.

* * * * *

Professor *Schmidt*, formerly of the University of Giessen, has been appointed professor of radio-activity in the School of Mines at Freiberg in Germany.

* * * * *

We learn from "Science" that Professor Bernhard *Kroenig*, professor of obstetrics at the University of Freiburg in Germany, has accepted an invitation to lecture on Roentgen and radium therapy before the American Surgical Society in Chicago.

* * * * *

The effect of radium in the treatment of cancer is to be made the subject of special investigation at Harvard Medical School, under the direction of Dr. William *Duane*. Dr. *Duane* has studied in the laboratory of Madame *Curie*, the discoverer of radium, and has been in touch also with the work of the Radium Institute in London. The announcement of the plan says that a group of investigators is being assembled to attack the problem of cancer treatment from various points of view.

* * * * *

The new Institute for Radium and Radiology in Heidelberg, under the direction of Professor *Lenard*, was formally opened on May 1st.

THE RADIO-ACTIVE ELEMENTS

C. H. VIOL, Ph.D.

Radio-activity, as generally understood, is the property which certain elements possess, of spontaneously sending out rays capable of penetrating through metals and other substances. These rays are further characterized by their ability to affect the photographic plate, to cause the discharge of electrified bodies, and to excite phosphorescence and fluorescence in some substances. *Rutherford* and *Soddy*, to account for the phenomena of radio-activity, assumed that, in the case of the radio-elements, the atoms become unstable and disintegrate. This transmutation takes place at a definite rate that is characteristic for each of the radio-active substances. As far as present experiments show, the rate of transmutation of the *radio-elements* is unchangeable, so that the time required for the decay of one-half of any amount of a radio-element, the so-called "*half decay period*," or, briefly, "*period*," is definite for each of the substances. Thus in 2,000 years half of all the radium now present in the world will have disappeared, 2,000 years being the *period* of radium. The transmutation of the radio-elements in usually accompanied by the violent shooting out of an alpha ray (positively charged helium atom), the remainder of the atom becoming an atom of a new element. In this way the atom of radium, a metal, changes into an atom of *niton* or *radium emanation*, a gas. This emanation atom in turn is unstable, and breaks up, giving off an alpha particle and forming an atom of a substance that has been named radium A. Radium A, being a solid substance, settles and forms the *active deposit* of radium. This radium A in turn decays, giving rise to radium B, which produces radium C. Radium C gives off not only alpha but also the beta and gamma rays, when it changes. The beta and gamma rays are more penetrating, being in nature like the cathode and Roentgen rays, respectively. It may be seen then, that radium salts freshly prepared will give only the alpha rays, but if the emanation is not lost, that is if the specimen is kept sealed, then this emanation will produce the active deposit, which contains radium C. It is by means of these gamma rays of radium C, which reach a maximum intensity about a month after the sealing of the radium preparation, that quantities of radium, from one hundredth of a milligram upwards, may most accurately be determined.

The radio-elements now known number about thirty, and may be grouped into four families—the uranium group, the radium group, the actinium group, and the thorium group.

In 1898 G. C. *Schmidt* and, independently, Madame *Curie* discovered that the element thorium is radio-active. In 1899 *Owens* discovered the thorium *emanation*, and in 1902 *Rutherford* and *Soddy* found the substance thorium X, which is being continually formed in thorium compounds and which in turn is the immediate parent of the thorium emanation. It was first supposed that thorium itself gave rise to thorium X, but later work has shown that there are three intermediate products between thorium and thorium X. Hahn in 1905 discovered the substance radio-thorium, which has been found to be the immediate parent of thorium X. In 1906 certain discrepancies found by *McCoy* and *Ross* and by *Boltwood* in the specific activity of thorium prepared from minerals and from commercial salts, led *Hahn* to suggest

that a "rayless" product came between thorium and radiothorium. This new substance was soon after found and called mesothorium. It was found to be complex, and the first product, which gives no rays in changing, is called mesothorium 1. This substance has a period of 5.5 years. A short-lived product coming between mesothorium 1 and radiothorium called mesothorium 2, decays with a period of 6.2 hours, giving rise to strong beta and gamma rays. It has been possible to separate and concentrate quite considerable quantities of the mesothorium 1 from the enormous quantities of residues left in process of manufacturing the pure thorium salts which are necessary for the incandescent mantle industry. This mesothorium, weight for weight, is much more active than even pure radium preparations. It is sold on the basis of its gamma ray activity being equal to the gamma ray activity of so many milligrams of radium, but it has a comparatively short life, being half decayed in 5.5 years. Thorium emanation, like radium emanation, gives rise to a solid form of radio-active material, which constitutes the thorium *active deposit*. Careful work has shown that this deposit is complex, consisting of a series of successive products which have been called thorium A, thorium B, thorium C_1, thorium C_2 and thorium D, respectively. The longest lived of these is thorium B, with a period of 10.6 hours, so that the decay of activity of the thorium active deposit takes place with this period. Thorium X can be separated from radiothorium preparations in which it forms, and it has been used in medicine, where it has been found to have a considerable effect on the blood, although in several cases injections of high doses of thorium X have led to fatal results.

The actinium series is characterized by the short periods of its products. Actinium itself gives off no rays, in changing, and its period is unknown. Radioactinium, the next product, has a period of 19.5 days, and actinium X, which forms from radioactinium, has a period of 10.2 days. Like thorium X and radium, actinium X gives rise to a gaseous form of radio-active matter, which is called the actinium *emanation*. This gas has a period of 3.9 seconds, and in decaying gives rise to a characteristic actinium active deposit. This active deposit is also complex, consisting of four successive products that have been called actinium A, actinium B, actinium C and actinium D. Actinium A, the product formed when the emanation atom changes, has a period of 0.0029 second—truly a short-lived element!

Since the period of radium is only 2,000 years, it is evident that in about 20,000 years practically all the radium now existing will have transmuted, and, in order to account for the presence of radium today, a longer-lived product must be sought. This parent is the element uranium. A number of researches, beginning with the work of *Boltwood, McCoy,* and of *Strutt,* have shown that there is a relation between the amount of radium and of uranium in most uranium minerals. Experiments were carried out to test whether the newly-formed radium could be detected in uranium initially freed from radium. The experiments gave negative results, and *Boltwood* found that there is a long-lived product, *ionium*, in the series between uranium, uranium X and radium.

Actinium is always found in the uranium minerals, and its origin is obscure, though it seems probable that it results as a branch product in the uranium series. That is, one of the products in the uranium series is thought to disintegrate in two fashions, one of the products

being actinium, the product of the other method of changing being a substance which finally leads to radium.

The following diagrammatic representation of these series of radio-active elements shows the order in which the products occur, their periods, and the rays which they give off in the process of their transmutation:

URANIUM 1 5,000,000,000 years alpha rays		
URANIUM 2 1,000,000 years (?) alpha rays		THORIUM 13,000,000,000 years alpha rays
URANIUM X 24.6 days beta, gamma rays		MESOTHORIUM 1 5.5 years Rayless
URANIUM Y 1.5 days beta rays	ACTINIUM Period unknown Rayless	MESOTHORIUM 2 6.2 hours beta, gamma rays
IONIUM 200,000 years (?) alpha rays	RADIO ACTINIUM 19.5 days alpha rays	RADIOTHORIUM 2 years alpha rays
RADIUM 2,000 years alpha rays	ACTINIUM X 10.2 days alpha rays	THORIUM X 3.65 days alpha rays
EMANATION (Niton) 3.86 days alpha rays	ACT. EMANATION 3.9 seconds alpha rays	TH. EMANATION 54 seconds alpha rays
RADIUM A 3 minutes alpha rays	ACTINIUM A 0.002 second alpha rays	THORIUM A 0.14 second alpha rays
RADIUM B 26.8 minutes beta, gamma rays	ACTINIUM B 36 minutes beta rays	THORIUM B 10.6 hours beta rays
RADIUM C 19.5 minutes alpha, beta, gamma rays	ACTINIUM C 21 minutes alpha rays	THORIUM C 1 60 minutes alpha rays
RADIUM D 16.5 years beta rays	ACTINIUM D 4.71 minutes alpha, beta, gamma rays	THORIUM C 2 Period very short (?) alpha rays
RADIUM E 5.0 days beta, gamma rays		THORIUM D 3.1 minutes beta, gamma rays
RADIUM F (polonium) 136 days alpha rays		BISMUTH (?)
LEAD (?)		

The study of the chemistry of the radio-elements presents many new problems of great difficulty. In the case of the "rare earths"

the great difficulty has been to separate the chemically similar elements and make certain that the substances so separated were really not mixtures. Thus the element long known as didymium was later separated by von *Welsbach* into two substances, which are called neodymium and praesodymium, which are supposed to be elements. In the case of the radio-elements this chemical similarity of elements is also encountered, and in some cases the resemblance of several elements is so great that no means so far tried avails to separate them, although the separate elements may be prepared in a state of radio-active purity by round-about means. Thorium, radiothorium, and ionium, when together, cannot be separated from each other, and this is also true of mesothorium and radium. Uranium is supposed to be a mixture of two inseparable products called uranium 1 and uranium 2. All the radio-elements are decaying with a period that is characteristic for each element, and this enables one to work with these elements and recognize their presence even when any ordinary means, such as the spectroscope or atomic weight determinations, etc., would be futile. Thorium and radiothorium are chemically identical and inseparable, but mesothorium, which comes between thorium and radiothorium as an intermediate disintegration product, may easily be separated from these. Mesothorium in turn produces radiothorium, which may then be separated in a state of radio-active purity, that is, quite free from thorium. Likewise if thorium is continually treated to remove the mesothorium as fast as it forms, the production of radiothorium in the thorium is prevented, and in the course of time (more than twenty years would be required for this particular case) the radiothorium originally present in the thorium, and inseparable from it, will decay finally, leaving thorium free from radiothorium.

Except in the case of radium and radium emanation, and the long-lived elements uranium and thorium, quantities of the radio-elements have not been prepared which would permit of accurate atomic weight determinations, and in the case of the greater number these elements of short life, it is doubtful whether such quantities will ever be obtained. This makes the study of the chemistry of these elements very difficult, and this problem is being attacked in several ways, notably by a study of the electrolytic behavior of the elements, by their behavior in the presence of other ordinary elements (e.g. the great resemblance of radium salts and barium salts would allow us to predict the nature of radium, even if it had not been possible to isolate the salts in a state of high purity, and to demonstrate that radium is a bivalent metal similar to barium), and by a study of their volatility.

The study of the phenomena of radio-activity and the properties of the radio-elements has proved valuable in ways too numerous to detail. We may now see the evolution of matter, the more stable forms resulting finally from the more complex; we realize somewhat of the enormous amounts of energy stored in our ordinary matter; geology and astronomy must take into consideration these new sources of energy, the radio-elements; and medicine has been endowed with valuable new agents which present great possibilities, even the dream of the old alchemists, the transmutation of matter, is now not to be scouted as beyond reason. We may not ever be able to actually cause the transmutation of ordinary forms of matter, we may never be able to unlock the tremendous stores of subatomic energy, but even if we should fail

in this, the efforts made cannot but be of the greatest benefit in teaching us much that is of value.

(This is the last of a series of three articles which Dr. C. H. *Viol*, of the Radium Research Laboratory of Pittsburgh, Pa., has written, to present to our readers in a short but comprehensive form an idea of the present status of radio-activity. The first article, dealing with "Radium and Its Rays," appeared in the April number, and the second, dealing with "The Production and Decay of Radio-active Matter," appeared in the May number of Radium.)

Reviews and Abstracts

Francis H. *Williams* and Samuel W. *Ellsworth*. "Treatment of superficial new growths by pure radium bromide." Journal of the American Medical Association, Volume 60, No. 22, page 1694, 1913.

The authors have worked with 120 milligrams of pure radium bromide and about 20 grams of less pure salt, about 50 milligrams of the purer material being generally used in the applicator, which was suitably screened with alluminum. Tabulated data on a total of 181 cases of cancers, affecting parts of the face, neck, hand and breast, show a total of 154 cases healed, 7 not healed, 3 under treatment, and 17 discontinued. Of the 154 listed as healed on Jan. 1, 1911, at present 135 are still healed, 16 have had recurrences, and there have been 3 deaths. Growths affecting the lymph nodes, the tongue, mouth and tonsils, respond to radium treatment only if taken in the very early stages, but in keloids, and in skin diseases such as eczema, warty growths, psoriasis and in birth marks, the treatment with radium has given excellent results. The following conclusions are given in regard to the application of radium:

"1. The application of pure radium bromide in sufficient amount, properly used, is a harmless, painless and efficient method of treating early superficial new growths. Radium is well adapted to cancers of the face, as the cosmetic results are excellent, and particularly to the eyelids, where operation may offer special difficulties and disadvantages. With proper care there is no danger to the eye."

"2. Operation is still considered today the method of choice in early skin cancers by most practitioners, but the results obtained here and abroad show, we believe, that radium should be used first in early cases, and operation reserved for such as are not readily controlled by it."

"3. Radium is more successful when it is the first treatment employed than when it is used after operation, X-rays or other forms of treatment, although even under these circumstances it does well."

"4. The number of treatments required in some cases is from two or three to ten, while in others more than twenty are needed. Improvement usually takes place after two or three applications of the radium."

"5. Many people dread the knife, even for a simple operation, and, fearing surgical interference will be advised, delay coming for

treatment, thus lessening the chances of recovery. Radium is free from dread, as its action is painless."

"6. The analgesic action of radium is noteworthy."

"7. For keloids, unless extensive, radium is by far the best treatment known to us."

"8. Where radium is obtainable, it would be well to use it for skin lesions of small area which do not heal readily under simple applications."

"9. All powerful remedies have dangers, but they can be avoided if care is taken. During the seventeen years the X-rays have been used at the Boston City Hospital, no patient has been burned, nor have any untoward results occurred in about ten years during which radium has been employed there."

J. *Kemen.* "Comparison of different methods of emanation treatment by means of examination of the blood." Radiologische Mitteilungen. Volume 5, page 25 (1913).

The question whether the undoubted results of treatment with baths containing radium emanation can be ascribed to the permeability of the skin for radium emanation has been answered by *Kohlrausch* and *Plate* in the negative. These authors ascribed the effects of radium emanation baths rather to the inhalation of this gas, out of the water, by the patient during the bath. The careful experiments of *Kemen* tend, however, to show that even if, by a special device, inhalation of the air of the bathroom is excluded, after a bath in water containing about 50 to 100 Mache units per air, the blood of the patient is radioactive, and contains from 1 to 4 Mache units per liter. This is about the same concentration as has been found by other authors in the blood of patients who have remained for one hour in an emanatorium room of 10 Mache units per liter air.

In other experiments, the author shows that even after application of a "radium compress" on the skin the blood acquired a concentration of 1.5 to 2.5 Mache units radium emanation per liter. This seems to prove conclusively the permeability of the skin for radium emanation. In this case, as in the case of radium baths, the effect of the radio-active decay products of radium, deposited on the skin, is probably also a factor in the results from this treatment.

F. *Gudzent* and W. *Neumann,* "Permeability of the Human Skin for Radium Emanation." Radium in Biologie und Heilkunde. Volume 2, page 144 (1913).

Working in the Radium Institute of the Royal Charity Hospital in Berlin (Director *His*), the author attacks the same problem as *Kemen* (see preceding abstract) by another way. A patient was placed nude in a very small hermetically sealed room, which was filled with

radium emanation of 120 Mache units per liter air. A mask was fitted to the mouth of the patient, so that he could inhale only inactive (external) air, and his exhaled air was collected and analyzed for radium emanation. The results show that under these conditions practically no radium emanation was exhaled, and the authors conclude that radium emanation does not enter the body through the skin.

The abstractor believes, however, that this experiment is not so conclusive as those of *Kemen*, because the method of measuring was not accurate enough to determine such a small concentration of radium emanation in the exhaled air as might reasonably be expected. Even assuming that the results of *Gudzent* and *Neumann* are correct, it is still possible that the wet skin permits the radium emanation to diffuse into the body more rapidly than does the dry skin. O. B.

E. *Vollmer*. "The Effects of Radium in Dermatology." Radiologische Mitteillungen, 1913, page 20.

A capsule with six milligrams of radium (element) was applied six to eight times for ten minutes without filters, but kept about a half an inch away from the skin: One case of tuberculosis of the skin (cheek) cured; one case lupus of the upper lip improved; one case epidermolysis digitorum manus utriusque permanently cured; one carcinoma of the cheek apparently cured; a few cases of psoriasis improved. O. B.

NEW BOOKS

E. *Sommer*. "On Emanation and Emanation Therapy. (German). 2 enlarged editions. Publ. Munich. Verlag der aerztlichen Rundschau, (1913), 161 pages.

E. *Frank*. Die Neueren Wendungen in der Pathologie and Therapie der Gicht. Urban and Schwarzenberg. Vienna, 1912.

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